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Apparatus and Method for Producing a Data Carrier

a Background of the Invention

The present invention relates to an apparatus and a method for producing a data carrier having at least two substrates adhered with a two-sided adhesive film.

Such data carriers are, for example, optical recording media such as DVDs, etc., that comprise at least two substrates adhered to one another. In one known apparatus for producing such a data carrier, as is known for instance from application DE-A-197 18 471, from the same applicant, two substrates were adhered to one another by means of a lacquer. Typically the lacquer is applied to the center of one of the substrates, which is then centrifuged in order to achieve the most uniform possible film of lacquer on the substrate. In addition, residual lacquer is centrifuged off of the substrate and must later be disposed of in a complex process. Once the layer of lacquer has been applied, the substrates are joined, whereby prior to their joining one of the substrates is bent such that it first comes into contact with the other substrate only in a central region. As the substrates are joined this bending is gradually eliminated so that the other regions of the wafers also come into contact with one another. This bending is advantageous for preventing air from being trapped between the substrates, which could affect the usability of the data carrier thus produced. However, both the centrifuging of the substrates when the layer of lacquer is applied and the bending of the substrates when they are joined involve the risk of damaging the substrates. In addition, the

process for applying the lacquer is very complex, and it is not always possible to obtain a uniform layer of lacquer throughout a plurality of lacquering processes. Furthermore, it is very time-consuming and expensive to dispose of the residual lacquer that is centrifuged off during the centrifuging process.

Known from EP-A-0 854 477 is a method for producing a data carrier in which two substrates are adhered to one another by applying to a first substrate a film that is coated on two sides with adhesive, aligning a second substrate with respect to the first substrate, and joining the substrates. The coated film maintained on a carrier film is moved over the first substrate using a transport apparatus, held in this position, and then using an elastic ram is moved into contact with the substrate and pressed thereupon. Then the ram is moved away from the substrate and the carrier film is withdrawn from the coated film using a roller.

In this process there is the risk that air bubbles that have a negative impact on the quality of the data carrier can be trapped between the substrate and the adhesive film. In addition, the process for applying the adhesive film is very time-consuming because movement of the film during the pressing and subsequent withdrawal of the carrier film must be stopped.

Starting with the apparatus described in the foregoing and the method for producing the data carrier, the object of the present invention is to provide an apparatus and a method that make it possible

to produce a high-quality data carrier simply and cost-effectively, in particular without trapping any air. The object of the present invention is furthermore to decrease the processing times required for adhering two substrates.

a Summary of the Invention

The object of the present invention is achieved inventively in a method of the type cited in the foregoing in that the adhesive film (25) is pressed onto the substrate (6) using a rotating pressure roller (33) while the substrate (6) and the pressure roller (33) are moved relative to one another. This prevents air from being trapped between the substrate and the adhesive film because the film is pressed onto the substrate along a straight line in a controlled manner. Furthermore, the movement of the film does not have to be stopped, which results in a continuous process. In addition to applying the film, the carrier film can be removed from the adhesive film in the same work step, thus accelerating the process even further.

In accordance with one particularly preferred embodiment of the present invention, during or after its application to the first substrate the adhesive film is withdrawn from a carrier film that has a required stability for making it possible to transport the adhesive film. The carrier film furthermore prevents one side of the adhesive film from prematurely adhering to other objects and prevents contamination of the adhesive film. Preferably a protective film is withdrawn from the side of the adhesive film opposite the carrier film prior to applying the adhesive film to the first substrate, the protective film preventing

contamination of the other side of the adhesive film prior to adhering to the first substrate.

In order to ensure that the substrates adhere well and uniformly, the shape and size of the adhesive film corresponds to those of the surfaces of the substrates to be adhered. This ensures that the substrates are adhered to one another across their entire surface and that no adhesive film projects over the surfaces that are not to be joined. Sections of the adhesive film that correspond to the shape and size of the substrates are preferably punched onto the carrier film. The adhesive film is preferably applied centered on the surface of the substrate to be adhered in order to achieve the advantages cited above. For this purpose the adhesive film and the substrate are aligned with one another prior to application.

The pressure of the pressure roller is preferably controlled.

Prior to pressing by the pressure roller, the adhesive film is preferably held at a pre-specified angle relative to the surface of the substrate in order to ensure that the adhesive film does not come into contact with the surface of the substrate prior to the pressure from the pressure roller. This ensures uniform pressure on the adhesive film and prevents air from being trapped between adhesive film and substrate. Preferably the substrate and the pressure roller are moved relative to one another while the adhesive film is being applied. The substrate is preferably moved past the pressure roller linearly, and the pressure roller is preferably rotated about its longitudinal axis

synchronously to the movement of the substrate in order to continuously adhere the adhesive film to the substrate.

In one preferred embodiment of the present invention, after the adhesive film has been applied to the first substrate the substrates are placed on a centering and holding element to align them. This ensures that the substrates are aligned with one another prior to being joined. The centering and holding element preferably spaces the substrates apart prior to their joining.

The substrates are preferably joined in a vacuum in order to prevent air from being trapped between the substrates. For joining the substrates, these are preferably pressed together in order to ensure good contact. Preferably the pressure exerted on the substrates is controlled. The adhesive film preferably responds to pressure and the adhesiveness changes depending on the pressure exerted. The adhesive film is hardened in another exemplary embodiment of the invention.

The object of the present invention is achieved in an apparatus for producing a data carrier having at least two substrates adhered to one another, which apparatus has a laminating station for applying to a first substrate a film that is adhesive on both sides and a substrate adhering station for aligning and joining the substrates, in that the laminating station (7) has a rotatable pressure roller (33) and a device (47) for moving the substrate (6) and/or the pressure roller relative to one another.

The advantages cited with regard to the method are achieved with such an apparatus.

Advantageously the apparatus has a centering and holding device that in a first position holds the substrates spaced from one another and in a second position enables centered joining of the substrates. The substrate adhering station preferably has a vacuum chamber in order to prevent air from being trapped between the substrates. The vacuum chamber advantageously has a hood and a base that is formed in one embodiment by a substrate support element that is part of the centering and holding device. Using the centering and holding device as a part of the vacuum chamber makes it possible to reduce the size of the vacuum chamber, and thus the costs associated with deaerating the vacuum chamber, to a minimum. Preferably the substrate adhering station has a pressure ram in order to securely join the substrates. The pressure ram is preferably parallel to a support surface of the substrates in order to ensure that the substrates are pressed together uniformly. In an alternative embodiment, an apparatus is provided for applying compressed air to one of the substrates, which makes it possible to press the substrates together in a particularly uniform manner.

In accordance with one preferred embodiment of the present invention, the pressure ram has an element for actuating the centering and holding device between the first and second positions for

controlled release of the holding function in the device for joining the substrates.

The adhesive film is advantageously one layer of an adhesive, whereby a film that is coated on both sides can be omitted. The use of one layer of pure adhesive improves the optical properties in the joining region of the substrates.

a Brief Description of the Drawing

The present invention is explained in greater detail in the following using preferred exemplary embodiments with reference to the figures, in which:

Fig. 1	is a schematic representation of an apparatus for producing data carriers in accordance with the present invention;
Fig. 2	is a schematic view of parts of a laminating station in accordance with the present invention;
Fig. 3	is a side view of an alternative embodiment of a laminating station in accordance with the present invention;
Figs. 4a-4c	illustrate a substrate adhering station for aligning and joining substrates in accordance with the present invention during various method steps.

a Description of Preferred Embodiments

Figure 1 illustrates an apparatus 1 for producing a DVD with two adhered substrate halves.

The apparatus has first and second feed units 3, 4 for feeding two substrate halves that form a DVD once they have been adhered. A

first substrate half 6 from the first feed station 3 is conveyed to a laminating station 7 that is described in greater detail with reference to Figures 2 and 3. In the laminating station, a pressure-sensitive adhesive tape or film is applied to the surface of the substrate half 6 to be adhered. The terms adhesive tape and adhesive film are to be understood as a layer of adhesive without a carrier material. The optical properties of a layer of adhesive can be controlled more precisely and better than those of a carrier material coated on both sides, as is known, for instance from EP A 0 854 477, cited in the foregoing. The first substrate half 6 is subsequently transported to a rotary table 8 and placed on a centering and holding device that is described in greater detail with reference to Figures 4a - c. Then the rotary table is rotated into a position in which a second substrate half 10 is also placed on the centering and holding device, whereby the two substrates are held centered over one another with a gap located between them, as will be described with reference to Figures 4a - c.

Then the rotary table is rotated further until the substrate halves arranged above one another are arranged in a processing station 11 for joining the substrates. The processing station 11 is described in more detail with reference to Figures 4a - c.

Once the substrate halves have been joined, they are rotated to an unloading position and loaded onto another rotary table. The rotary table transports the joined substrates to a scanning unit 16 in which the joined substrates are scanned to determine if they have been

damaged. If there is damage, they are deposited in a station 18 and then discarded. Otherwise they are deposited on a table 20 and collected for further processing.

The apparatus 1 is arranged in a clean room in which each of the work steps can be performed under clean room conditions.

Figures 2 and 3 are schematic representations of a laminating station 7 in accordance with the present invention, whereby the components of the laminating stations 7 illustrated in Figures 2 and 3 are arranged somewhat differently. However, the same reference numbers are used for identical/similar components in the following description of the laminating station in accordance with Figures 2 and 3.

The laminating station 7 has a feed roller 22 on which a tape-like laminating film 23 is rolled. The laminating film 23 comprises a total of three films, namely, a protective film 24, an adhesive film (adhesive layer) 25 that is adhesive on two sides, and a carrier film 26, as can be best seen in the enlarged circular detail in Figure 2. The adhesive film 25 has sections 27 that are punched corresponding to the size and shape of a surface of the substrate half 6 that is to be adhered. The adhesive layer is an adhesive film that reacts to pressure and that is generally known as PSA tape, the adhesion properties of which can be adjusted via the pressure exerted.

The laminating station furthermore has a take-up roller 28 on which the remainder of the laminating film 23 is taken up after a

laminating process. The laminating film 23 is conducted between the feed roller 22 and the take-up roller 28 around a plurality of guide rollers 30 through 38 in order to provide a defined path for the tape-like laminating film 23 between the rollers 22 and 28. Each of the rollers 30 through 38 is rotatable about its axis of rotation, and the rollers 31 and 37 are designed as so-called compensating rollers that are borne movable in the horizontal direction in order to make it possible to compensate for the length of the laminating film 23 between the rollers 22 and 28. This makes it possible for the rollers 22 and 28 to be rotated at a constant speed despite discontinuous laminating cycles, as will be described in the following. The parts of the adhesive film 25 that are not needed can be removed in advance, that is, prior to introducing the laminating film into the laminating station, for instance during production of the laminating film, or they can remain on the film in order to ensure a uniform thickness of the film 23 across the entire width and length thereof, at least prior to a laminating process.

The laminating film 23 is furthermore conducted around a wedge-shaped blade 40, where the laminating film 23 turns sharply in order to make it possible to remove the protective film 24 from the laminating film 23 so that one side of the adhesive film 25 is exposed for adhering to one substrate half 6. The removal of the protective film 24 is best seen in Figure 3. Once removed, the protective film 24 is rolled onto a roller (not shown in greater detail). An alternative type of

film removal device could also be used instead of the wedge-shaped blade 40.

Once the laminating film 23 has been conducted around the blade 40, it is conducted around the roller 33 that is lower with respect to a horizontal and that is embodied as a pressure roller. After the roller 33, the laminating film 23 is conducted about the shaft 34, which is driven via a motor 42.

Rotation of the driven roller 34 causes corresponding rotation of the pressure roller 33 and a downstream roller 35 that is embodied purely as a guide roller.

The laminating station 7 has a first sensor 45 that is associated with the driven roller 34 and that is able to detect contours in the punched sections 27 of the adhesive film 25. The laminating film 23 is moved back and forth in the longitudinal direction via the driven roller 34 until the sensor 45 detects a certain contour of the punched sections 27, such as for instance a punched center hole. When the sensor 45 detects the center hole, it is positioned directly over one edge of the center hole by the movement of the film, this resulting in precise alignment of the section 27 with respect to the roller 34 and in particular the pressure roller 33 in the longitudinal direction of the laminating film 23.

The laminating station 7 furthermore has a support and transport unit 47 for the substrate half 6 to be laminated. The support and transport unit 47 forms a horizontal support for the substrate half 6 and

can be moved in ny direction via suitabl e moving apparatus (not shown in greater detail). A lowerable centering pin 48 ensures precise alignment of the substrate half 6 on the support and transport unit 47. The pin 48 can be lowered during the laminating process so that it is not impaired. This is achieved in that it is pressed upward into the position shown in Figure 3 by a spring with relatively limited spring force. When pressure is exerted on the pin from above, it is pressed downward against the spring force. Alternatively, the pin can be moved via a cylinder or motor.

Prior to the lamination of the substrate 6, the transport and support unit 47 is moved in the X direction, which corresponds to the longitudinal direction of the laminating film 23, against a stop. This ensures that the substrate 6 and the section 27 of the adhesive film 25 previously aligned in the longitudinal direction are aligned to one another. Then the transport and support unit 47 is moved back and forth in the Z direction, which runs transverse to the longitudinal direction of the laminating film 23. A sensor pair 50 allocated to the transport and support unit 47 detects a contour, such as for instance the contour of a center hole, of the punched section 27 of the adhesive film 25, which makes it possible to laterally align the substrate half 6 with respect to the section 27.

Once the substrate half 6 has been aligned in the above manner both in the X direction and in the Z direction with respect to the section 27 of the adhesive film 25, the transport and support unit 47 is raised in

the Y direction. Now the motor 32 drives the roller 34, which causes the laminating film 23 to move in the X direction. At the same time and synchronized with the rotation, the transport and support unit 47 is moved in the X direction. The section 27 comes into contact with the surface of the substrate 6 to be adhered and is pressed thereagainst by the pressure roller 33 so that it adheres to the substrate half 6 and detaches from the carrier film 26. The synchronized movement of the drive roller 34 with the transport and support unit 47 applies a section 27 of the adhesive film 25 centered on the substrate half 6 so that the section 27 of the film 25 completely covers the side of the substrate N.E half 6 to be adhered and does not project over the edge. The pressure of the pressure roller in the Y direction is controlled via the position of the transport and support unit 47 in order to control the adhesion properties of the adhesive film 25. Alternatively, of course, the pressure roller 33 can move in the direction of the transport and support unit. A spring-type suspension system can be provided for good control or compensation of the pressure. The spring-type suspension can be provided via a spring or compressed air cylinder.

Then the substrate half 6 thus provided with the section 27 of adhesive film 25 is transported via a suitable handling apparatus 52, such as an interior hole gripper, removed from the transport and support unit 47, and is transported to the rotary table 8 in accordance with Figure 1.

A new substrate half 6 is loaded onto the transport and support unit 47, and the process is repeated. As was mentioned in the foregoing, the rollers 22 and 28 rotate continuously during the entire process, although the adhering process is not continuous. The longitudinal compensation of the laminating film 23 that is therefore necessary is achieved via a horizontal movement of the compensating rollers 31 and 37, as already mentioned in the foregoing.

Although the laminating film has three layers in accordance with the description in the foregoing, namely a protective film 24, an adhesive film 25, and a carrier film 26, it should be noted that it is not absolutely necessary for there to be a protective film 24. However, if no protective film 24 is used, at least the rollers 30 and 32 should be specially coated in order to prevent the exposed adhesive film 25 from adhering to these rollers. Furthermore, the adhesive film 25 must also not be a film that responds to pressure, and it can also be formed by a carrier material coated on two sides instead of one purely adhesive layer.

Alternatively, the rollers up to the roller 33 can be omitted, whereby in this case the rollers 22 and 28 must be controlled such that the sections 27 are aligned and a movement of the laminating film 23 is achieved synchronized with the transport and support unit 47.

In addition, a single sensor, such as for instance a camera, can be used for the above alignment processes instead of the sensors 45 and 50.

Once the substrate half 6 has been removed from the laminating station, as already mentioned it is placed onto the rotary table 8, which has four arms 55 with substrate receiving units 56 suspended thereon.

The receiving units 56 are suspended on the arms 55 via mounting flanges 57, as can be seen in Figures 4a - c. The support unit 56 can be raised from the suspension, as Figure 4c illustrates.

The receiving unit 56 has a support plate 58 with an even or planar surface 59 upon which the first substrate half 6 is placed, as Figures 4a - 4c illustrate. The receiving unit 56 furthermore has a centering and holding pin 60 with movable holding noses 61 that are able to hold the second substrate half 10 over the first, laminated substrate half 6 with a gap 63, as Figure 4b illustrates. On the same date it filed the instant application, this applicant filed a patent application entitled, "Apparatus for Joining Substrates", which describes the design and precise function of the holding pin 60. In order to avoid repetition, please refer to this application, which is made the subject of the present invention.

The rotary table 8 brings each of the arms 55 with the receiving units 56 sequentially into different positions that are labeled 1, 2, 3, and 4 in Figure 1.

In a first position, a laminated substrate half 6 is placed on the receiving unit 56. The substrate half 6 is moved via the noses 61 of the centering and holding pin 60 until it is supported on the even surface 59 of the support 58, as Figure 4a illustrates.

Then the receiving unit 56 is moved into the position labeled 2. There the second substrate half 10 is likewise placed on the substrate receiving unit 56, whereby the pin 60 centers the substrate half 10 and holds it spaced over the first substrate half 6, as Figure 4b illustrates.

Then the receiving unit 56 is moved into position 3 in the joining station 11.

In the joining station 11, the receiving unit 56 is placed on a

a support "63" by lowering the arm 55 of the rotary table 8, as the arrow in Fig 4c indicates. Now the receiving unit 56 is completely borne by the support 63 and is largely detached from the arm 55 of the rotary table 8. Furthermore, in the joining station a hood 65 is moved over the receiving unit 56 and sealingly brought into contact with the even surface 59. This forms a closed chamber 66 between the hood 65 and the support 58 in which the substrate halves are received. The chamber 66 can be deaeratd or vented via an apparatus (not shown in greater detail). A ram 67 is received vertically movable in the chamber 66 and extends in a sealed manner through an upper wall of the hood 65. In order to ensure the integrity of the chamber 66, the part of the ram 67 extending through the upper wall 65 is surrounded by a bellows (not shown in greater detail), one end of which is sealingly attached to the ram 67 and the other end of which is sealingly attached to the upper wall of the hood 65.

The ram 67 is vertically movable within the chamber 66, as the double arrow in Fig. 4c indicates. In Figure 4c, the ram 67 is shown in

a lowered position in which it presses the first and second substrate halves 6, 10 together. When pressing the substrates together, the ram 67 presses the substrate half 10 in the direction of the substrate half 6, whereby the noses 61 are pressed into the pin 60. In this process, the substrate half 10 is guided centered very precisely relative to the first substrate half 6 by the pin 60.

The noses can be pressed into the pin 60 by the forces exerted on the substrate 10. Alternatively, the noses can also be withdrawn into the pin 60 by an actuating mechanism provided in the ram. Such a mechanism is described for instance in the patent application cited above.

The pressure from the ram is controlled by a control apparatus (not shown in greater detail).

After the two substrate halves 6, 10 have been pressed together, the chamber 66 is aerated and then the ram 67 is raised together with the chamber 66. Then the arm 55 of the rotary table 8 is raised again in order to receive the receiving unit 56 again, and then it is moved further into position 4. There the two joined substrate halves are removed, placed on another rotary table 14, and processed further, as described with reference to Figure 1.

The present invention was described in the foregoing using a preferred exemplary embodiment of the invention, without, however, being restricted to this special exemplary embodiment. In particular, the apparatus described and the method described are not limited to

joining DVDs. In addition, it is possible, for instance, to replace the ram 67 with an apparatus that presses the two substrate halves 6, 10 together by means of compressed air. Such an apparatus has for instance an interior and an exterior O-ring on a plate in order to form a sealed chamber between the plate and a back side of the second substrate half 10. This chamber can be subjected to compressed air via the plate in order to press the two substrate halves together. This would result in a very uniform surface pressure that is contactless except for the O-rings, thus preventing limitations of the optical properties of the substrate half, for instance by scratching the back side of the second substrate half 10. A similar apparatus could also alternatively or additionally be formed in the receiving unit 56. The adhesive film used can be a so-called PSA tape that changes its adhesive properties depending on the pressure applied. Alternatively, the adhesive film can also be hardenable. The second substrate half can be made of an elastic material, such as a protective tape, which protects the surface of the substrate adhered with the adhesive film.